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SURGICAL TUBULAR SHAFT INSTRUMENT

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Request for examination pursuant to §44 PatG [German Patent Act] has been submitted.

The following statements are taken [unedited] from the documents submitted by the applicant.

Abstract

In a surgical tubular shaft instrument comprising a tubular shaft, a movable tool attached to one end of said shaft, and a push and pull element that is sliding endwise in said shaft so as to move the tool, it is possible to improve the guide mechanism of the push and pull element even in cases in which the shaft is curved by bending the shaft and by designing the push and pull element at least in the bent section of the shaft as a rod made of an elastic material, which rod rests against the inside wall of a rigid sleeve which surrounds said rod and which runs concentrically with respect to the shaft and the cross section of which rod, in certain sections, is reduced by a plurality of circumferential grooves that are axially disposed side by side.

Description

The subject matter of the present invention relates to a surgical tubular shaft instrument comprising a tubular shaft, a movable tool which is attached to one end of said shaft, and a push and pull element which is sliding endwise in said shaft so as to move the tool.

This type of tubular shaft instrument is described and illustrated in EP 05 77 423 A2.

The push and pull element used is a rod which extends along the entire length of the shaft and which, on its free end, supports a head which is guided in the shaft and which establishes a connection to a manipulating element of the tool.

At high mechanical stress, the prior-art design runs the risk that the rod-shaped push and pull element buckles sideways when it is advanced.

Furthermore, this prior-art designs makes it impossible to produce tubular shaft instruments with a curved shaft, such as is needed for a number of surgical applications.

Based on this background art, the problem to be solved by the present invention is to design a generic tubular shaft instrument so as to ensure that the push and pull element is smoothly guided even if the shaft is curved, especially if high shearing and tensile forces are transmitted.

According to the present invention, this problem is solved in that the shaft of the tubular shaft instrument of the type described above is bent and that the push and pull element at least in the bent section of the shaft is designed as a rod made of an elastic material, which rod rests against the inside wall of a rigid sleeve which surrounds said rod and which runs concentrically with respect to the shaft and the cross section of which rod, in certain sections, is reduced by a plurality of circumferential grooves that are axially disposed side by side.

Thus, the push and pull element is designed in the shape of a rod and is guided in the bent section of a sleeve which prevents said push and pull element from buckling sideways at any time. To ensure that the bent section of the rod has an optimum flexibility, provision is also made for the cross section of the rod to be reduced in certain sections, which is accomplished by circumferential grooves that are disposed side by side. Between the circumferential grooves, sections remain in which the diameter of the rod is not reduced, thus ensuring that in these sections, the rod is securely guided along the inside wall of the sleeve. These guide surfaces between the circumferential grooves thus form support areas on the sleeve which, while ensuring an excellent guide mechanism, contact the sleeve only in a small region along its length so that the frictional losses are very low. As a result, even under high stress, the rod is mounted in the sleeve so as to be very easily movable and is able to adapt to the curvature.

In principle, it is possible for the sleeve to be designed as a separate part, for example, in surgical tubular shaft instruments in which several channels are disposed inside the shaft; however, according to a preferred embodiment of the invention, the sleeve can be formed by the shaft as such. Thus, when this solution is used, the entire cross section of the shaft is occupied by the rod, with said rod resting against the shaft only in certain areas.

It is useful if the circumferential grooves are disposed directly side by side, i.e., if between adjacent circumferential grooves only a very short section remains in which the rod rests against the sleeve. In particular, it can be provided that, in these circumferential sections in which the diameter is not reduced, the rod rests linearly, i.e., not areally, against the sleeve. This also contributes to reducing the friction and increasing the ease of movement.

An especially preferred embodiment provides that, in the longitudinal section of the rod, the transitional region between two adjacent circumferential grooves is arched. This necessarily ensures that the circumferential area that is not reduced rests linearly against the sleeve.

In a first preferred embodiment, the cross section of the circumferential grooves has an arched design.

In another embodiment, the circumferential groove can have a bottom that runs parallel to the longitudinal direction of the rod, with arched marginal areas being adjoined on both sides of said bottom. Thus, in the axial direction, the rod has alternating circumferential areas, the circumference [sic; cross section] of which is not reduced, and circumferential areas, the cross section of which is reduced. The circumferential areas with the non-reduced circumference and the circumferential areas with the reduced circumference are connected to one another by means of arched transitional sections. In other words, one can say that in this embodiment, the rod has a circumference that is smaller that the circumference of the sleeve and that at axial intervals, circumferential sections with an larger cross section are disposed on the rod, in which circumferential sections the rod rests against the sleeve and is guided therein. These

circumferential sections with an enlarged diameter are disposed on the rod like pearls in a necklace.

It is useful if the width of the circumferential groove is two to ten times larger than its depth, i.e., if the circumferential groove is relatively shallow. The width can, however, also be larger, especially if the curvature of the shaft is small and if, along the length of the bent region a few guide points for the rod are sufficient.

It is useful if the depth of the circumferential groove measures between 0.3 and 0.7 of the radius of the rod, which means that in the areas with a reduced diameter, the rod has a diameter which measures only 2/3 to 1/3 of the maximum diameter.

The rod may be made, for example, of high-grade steel. In an especially preferred practical example, however, it is provided that the rod be made of a material which has pseudoelastic properties at room temperature. Such materials are so-called "shape memory alloys" which, in certain temperature ranges, are able to undergo overproportionate changes in volume and thus overproportionate expansions as a result of a phase transition under stress. This effect is also known as "pseudoelasticity." An example of such an alloy is a nickel-titanium alloy (e.g., "Nitinol").

It is useful if the rod is connected to the manipulating element of the tool via a ball-and-socket joint. This ball-and-socket joint not only ensures that no undesirable lateral forces are transmitted from the rod to the manipulating element but also makes possible a rotation between the rod and the tool relative to the longitudinal axis of the rod.

In another embodiment, the rod is designed in one piece with a manipulating element of the tool, which means that the rod practically forms a part of the tool.

While in principle it is possible to design the rod in one piece with the remaining push and pull element, a preferred embodiment provides that the rod be connected to the remaining push and pull element via a detachable connection, in particular a detachable connection which is formed by a collet. This solution is especially advantageous if the rod is permanently connected to the tool. Thus it is possible to separate it so as to be able to disassemble the entire instrument for cleaning or for replacing individual pieces.

Furthermore, it is especially advantageous if the tool is attached to the shaft via a detachable connection, in particular a detachable connection designed as a collet. Again, this considerably facilitates the disassembly, the cleaning and the replacement of parts.

The following description of preferred embodiments of the present invention in association with the drawing serves to explain the invention in greater detail. As can be seen:

Figure 1 shows a view of a longitudinal section through the front portion of a first preferred embodiment of a surgical tubular shaft instrument with a flexible rod as part of the tool;

Figure 2 shows a diagrammatic representation of a partial longitudinal section through a tool for use on a tubular shaft instrument, and

Figure 3 shows a view similar to the one seen in Figure 1 of a different tubular shaft instrument with a ball-and-socket joint between the rod and the tool.

The tubular shaft instrument illustrated in the drawing, of which only the tubular front end near the tool is shown in the drawing, comprises a tubular shaft 1, to the free end of which tool 2 is detachably attached. In the practical example shown, this tool 2 is a pliers-like tool, it comprises two jaws 3,4 which are attached so as to be swiveled with respect to each other and which are supported in a mounting support 5 (not specifically shown in the drawing) so as to be swiveled in a manner known in the art. A tool might, however, also be designed in a different manner, for example, instead of having clamping jaws 3 and 4, two blades that can be swiveled relative to each other could be provided, or one blade or clamping jaw could be stationarily affixed while only the other blade or clamping jaw can be swiveled, or tool components that are movable in an axial direction relative to each other could be provided. The person skilled in the art is aware of many alternatives that could be used here.

Mounting support 5 has a cylindrical protuberance 6 which can be inserted into the free end of shaft 1 and which subsequently rests against the inside wall of shaft 1. In the end region resting against protuberance 6, shaft 1 is divided by longitudinal sections into individual tongues 7 which, in the radial direction, can be elastically bent outwardly and which, at their free end 8, are bent inwardly and there engage in a circumferential groove 9 of protuberance 6. By thus engaging in the circumferential groove, tongues 7 secure tool 2 against an axial movement. This securement can, however, be overcome by forcefully pulling tool 2 from shaft 1 since this pulling maneuver causes tongues 7 to be elastically bent outwardly, thus causing their inwardly bent free ends 8 to be disengaged from circumferential groove 9.

To permanently fix this securement, a cylindrical sheath 10 is disposed on shaft 1 so as to be longitudinally movable, which sheath can be made, for example, of PTFE (polytetrafluoroethylene). In its advanced position (Figure 1), it covers tongues 7, thus ensuring that said tongues cannot be radially bent outwardly. Thus it is not possible to pull tool 2 from shaft 1. But when sheath 10 is retracted far enough so that tongues 7 are exposed, said tongues can be radially bent outwardly, thus making it possible to pull tool 2 from shaft 1 in the manner described. Thus, the described connection between the shaft and the tool is designed so as to resemble a collet and to allow tool 2 to be detachably secured to shaft 1.

At the same time, sheath 10 can serve as an insulating sheath since it is made of an electrically insulating material. In a preferred embodiment, the material selected is transparent, thus allowing visual inspection of cleanliness.

In a central longitudinal channel 11 of tool 2 which extends through the entire mounting support 5, a rod-shaped manipulating element 12 is disposed so as to be able to slide endwise, which manipulating element, when moved relative to mounting support 5, manipulates tool 2, i.e., for example, by swiveling jaws 3,4 one relative to the other. This is implemented by means of a suitable drive mechanism which is not shown in the drawing since the person skilled in the art is aware of the wide variety of such mechanical drive mechanisms.

In its front section directly adjoining tool 2 as well as in its rear section which adjoins a handle part not shown in the drawing, shaft 1 is straight. Between these straight areas, shaft 1 is bent, with the bent section 13, as a rule, extending only along a relatively short portion of the shaft length and with the angle of curvature selected differing as needed, but normally being in the range between, for example, 10° and 90°, but different angles are possible as well.

Inside shaft 1, a rod-shaped push and pull element 14 is disposed in the straight section adjoining the handle part, which push and pull element is connected to manipulating element 12 which will be explained in greater detail below. To implement this connection, a rod 15 made of an elastic material, for example, high-grade steel or preferably a shape memory alloy, such as a nickel-titanium alloy, is disposed in the bent section 14 inside shaft 1. This rod 15 has an outside diameter which is only very slightly smaller than the inside diameter of shaft 1, which means that generally rod 15 lies substantially very close to the inside wall of shaft 1 and thus follows the curvature of said shaft. In the longitudinal direction of rod 15, a plurality of circumferential grooves 16 are disposed in this rod, with these grooves having a flat basin-shaped cross section and with the bottoms 17 of said grooves in the practical examples shown running parallel to the longitudinal direction of rod 15.

Longitudinal grooves 16 are located so as to be relatively close to one another, thus leaving only a very short section 18 with a non-reduced diameter between adjacent longitudinal grooves 16. In this section 18, the rod in the practical example shown has an arch-shaped cross section, thus resulting in a substantially linear contact between section 18 and the inside wall of shaft 1, with rod 15 being guided inside shaft 1 only in the region of this linear contact while the cross section of shaft 15 in all in-between sections that are defined by the circumferential grooves 16 is reduced. This reduction can be of such a degree that rod 15 is reduced to 1/3 of the maximum diameter. By reducing the diameter, a markedly increased flexibility of rod 15 results in the reduced areas, thus ensuring that the rod can readily follow the curvature of shaft 1; however, because of the sections with a maximum diameter that lie between the reduced sections, rod 15 is securely guided along the inside wall of shaft 1, and support areas by means of which the rod is guided in shaft 1 result at axial intervals.

In the practical example shown in Figure 1, rod 15 is designed in one piece with manipulating element 12 of tool 2; on the end facing away from tool 2, rod 15 has a beadlike

thickening 19 which forms a detachable ball-and-socket joint 20 with a rod-shaped push and pull element 14.

For this purpose, the free end of push and pull element 14 is designed so as to be similar to shaft 1 and has elastically outwardly bendable tongues 21 which surround the beadlike thickening 19 and thus result in an axial securement. Tongues 21 are normally covered by shaft 1 and thus are prevented from bending in a radial direction. When shaft 1 is removed in this area, tongues 21 can be elastically bent outwardly and expose connection 20. To make it possible for shaft 1 to be moved, shaft 1 in the area of connection 20 is designed so as to be detachable so that the straight portion of shaft 1 can be removed from bent section 13.

In the practical example shown in Figure 3, rod 15 is designed in one piece with the push and pull element, and thus the free end of rod 15 is connected to manipulating element 12 by way of a ball-and-socket joint 22. This ball-and-socket joint 22 can establish a permanent connection, but in principle, it is also possible for this ball-and-socket joint to be designed in the form of a detachable connection 20 so that this embodiment makes disassembly possible in this area.

Claims

1. A surgical tubular shaft instrument comprising a tubular shaft, a movable tool which is attached to one end of said shaft, and a push and pull element which is sliding endwise in said shaft so as to move the tool, characterized in that the shaft (1) is bent and that the push and pull element (14) at least in the bent section (13) of the shaft (1) is designed in the form of a rod (15) made of an elastic material, which rod rests against the inside wall of a rigid sleeve (1) which surrounds said rod and which runs concentrically with respect to the shaft (1) and the cross section of which rod, in certain sections, is reduced by a plurality of circumferential grooves (16) that are axially disposed side by side.

2. The tubular shaft instrument as in Claim 1, characterized in that the sleeve is formed by the shaft (1) as such.

3. The tubular shaft instrument as in Claim 1 or 2, characterized in that the circumferential grooves (16) are disposed directly side by side.

4. The tubular shaft instrument as in Claim 3, characterized in that in the circumferential areas (18) with a non-reduced diameter, the rod (15) rests linearly against the sleeve (1).

5. The tubular shaft instrument as in Claim 4, characterized in that in the longitudinal section of the rod (15), the transitional area (18) between two adjacent circumferential grooves (16) is arched.

6. The tubular shaft instrument as in any of the preceding claims, characterized in that the cross section of the circumferential grooves (16) is arched.

7. The tubular shaft instrument as in any one of Claims 1-5, characterized in that the circumferential groove (16) has a bottom (17) which runs parallel to the longitudinal direction of the rod (15) and which is adjoined on both side by bent marginal areas.

8. The tubular shaft instrument as in any one of the preceding claims, characterized in that the width of the circumferential groove (16) is two to ten times greater than its depth.

9. The tubular shaft instrument as in any one of the preceding claims, characterized in that the depth of the circumferential groove (16) measures between 0.3 and 0.7 of the radius of the rod (15).

10. The tubular shaft instrument as in any one of the preceding claims, characterized in that the rod (15) is made of a material which has pseudoelastic properties at room temperature.

11. The tubular shaft instrument as in any one of the preceding claims, characterized in that the rod (15) is connected to a manipulating element (12) of the tool (2) by way of a ball-and-socket joint (22).

12. The tubular shaft instrument as in any of Claims 1-10, characterized in that the rod (15) is designed in one piece with a manipulating element (12) of the tool (2).

13. The tubular shaft instrument as in any one of the preceding claims, characterized in that the rod (15) is designed in one piece with the remaining push and pull element (14).

14. The tubular shaft instrument as in any one of Claims 1-12, characterized in that the rod (15) is connected to the remaining push and pull element (14) by way of a detachable connection (20).

15. The tubular shaft instrument as in Claim 13, characterized in that the detachable connection (20) is formed by a collet.

16. The tubular shaft instrument as in any one of the preceding claims, characterized in that the tool (2) is mounted to the shaft by way of a detachable connection (6,7,10).

17. The tubular shaft instrument as in Claim 16, characterized in that the detachable connection is designed in the form of a collet (6,7,10).

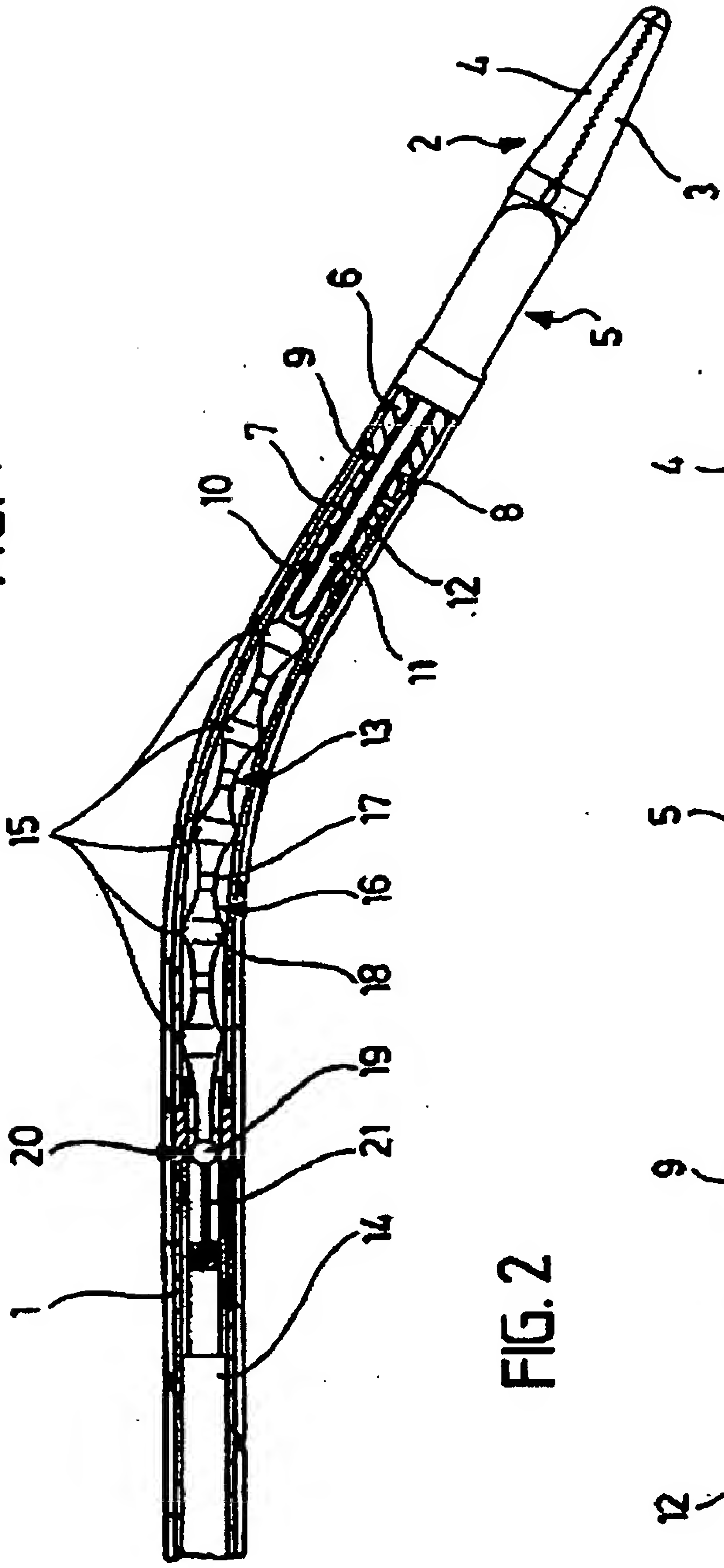

FIG. 1

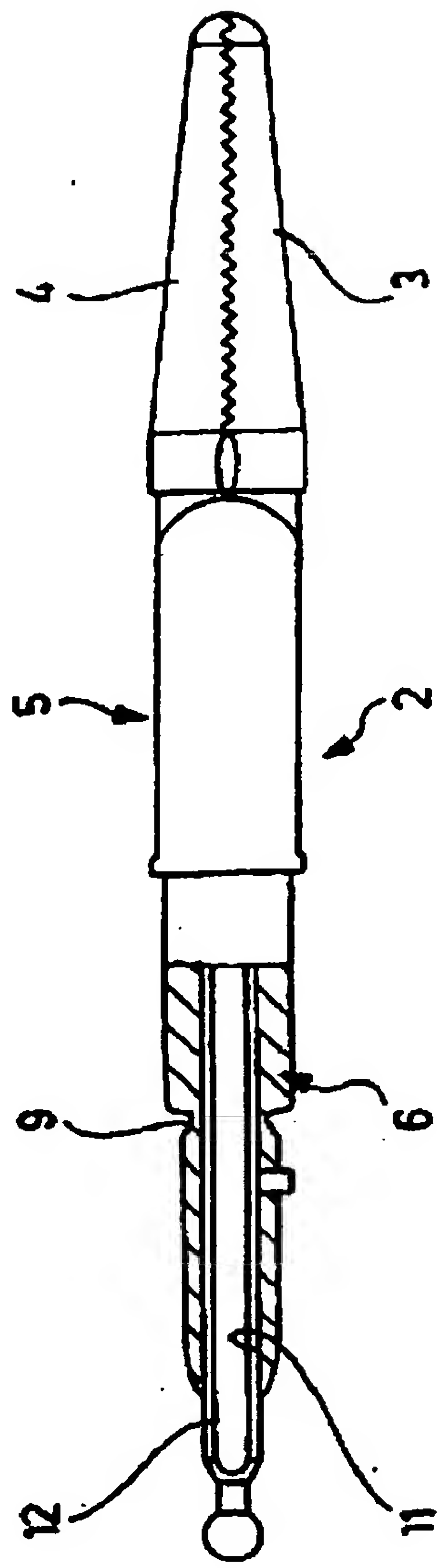

FIG. 2

FIG.3